IEEE P802.11  
Wireless LANs

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| Proposed Draft Text  MAC MLO EMLMR TBDs | | | | |
| Date: 2021-2-26 | | | | |
| Author(s): | | | | |
| Name | Affiliation | Address | Phone | email |
| Young Hoon Kwon | NXP |  |  | younghoon.kwon@nxp.com |
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Abstract

This submission proposes draft text for resolving TBDs in sub-clause 35.3.14 Enhanced multi-link multi-radio operation of 802.11bd Draft 0.2, which are:

* An MLD with dot11EHTEMLMROptionImplemented equal to true shall set the EMLMR Support subfield of the TBD Capabilities element, which indicates MLD level capabilities, to 1; otherwise, the MLD shall set the EMLMR Support subfield to 0.
* A non-AP MLD with dot11EHTEMLMROptionImplemented equal to true operates in the EMLMR mode by TBD signaling.
* A non-AP MLD with dot11EHTEMLMROptionImplemented equal to true may indicate its link switch delay in a TBD management frame.

Revisions:

* Rev 0: Initial version of the document.
* Rev 1: Incorporated email discussion results.
* Rev 2: Removed EML capabilities definition and editorial change for EMLMR switching behavior
* Rev 3: Undeleted EML capabilities definition
* Rev 4: Modified text for EMLMR mode switch

**Discussions:**

1. EMLMR support capability indication:

* As EMLMR support capability is an MLD level capability, it is reasonable to use Common Info field of an ML element to carry this information.

1. EMLMR enabling/disabling mode indication:

* Two candidate solutions are possible: Use of A-Control subfield or use of management frame exchange.
* Considering that EMLMR mode switching happens once in a while depending on operation scenario changes, it is preferrable to use management frame exchange compared to A-Control subfield.
* In this sense, an action frame is defined to carry this information, which can be applied to both EMLSR and EMLMR mode switching as EMLSR/EMLMR share the same mode switching concept.

1. Indication of link switch delay:

* In EMLSR operation, the link switch delay is defined as for a Padding field in a Trigger frame.
  + In EMLSR operation, the initial control frame is limited to a Trigger frame in non-HT (duplicate) PPDU format.
  + Therefore, limiting the addition of required padding to the Padding field is reasonable.
* However, in EMLMR operation:
  + Initial frame exchange follows per-link spatial stream capabilities and operating mode, and there’s no additional restriction.
  + Therefore, we cannot restrict the addition of required padding to the Padding field in a Trigger frame.
  + Rather, we better follow general padding rule of 11ax Trigger frame:
    - An AP may use any type of padding to satisfy the MinTrigProcTime requirement of a non-AP STA, such as using the Padding field in a Trigger frame, post-EOF A-MPDU padding, or aggregating other MPDUs in the A-MPDU.
* EMLMR Delay field is defined in a MLD level element (Common Info field of the basic variant ML element) for this purpose.
  + Similar values as EMLSR Delay field is used.

***TGbe editor: Modify the subclause 9.6.35.1 (EHT Action field) as follows:***

9.6.35 EHT Action frame details

9.6.35.1 EHT Action field

An EHT Action field, in the octet immediately after the Category field, differentiates the EHT Action frame formats. The EHT Action field values associated with each frame format within the EHT category are defined in [Table 9-526q (EHT Action field values)](#bookmark56).

### Table 9-526q—EHT Action field values

|  |  |
| --- | --- |
| **Value** | **Meaning** |
| 0 | EHT compressed beamforming/CQI |
| 1 | Enhanced Multi-Link (EML) Operating Mode Notification |
| 2–255 | Reserved |

***TGbe editor: Add a new subclause 9.6.35.x after the end of 9.6.35.2 (EHT Compressed Beamforming/CQI frame format) as follows:***

9.6.35.x EML Operating Mode Notification frame format

The Enhanced Multi-Link (EML) Operating Mode Notification frame is used to indicate to an AP MLD that a non-AP MLD with which the transmitting STA is affiliated is changing its Enhanced Multi-Link operation status and/or Enhanced Multi-Link operation parameters.

The Action field of the EML Operating Mode Notification frame contains the information shown in Table 9-xyz1 (EML Operation frame Action field format).

|  |  |
| --- | --- |
| **Table 9-xyz1 – EML Operating Mode Notification frame Action field format** | |
| **Order** | **Information** |
| 1 | Category |
| 2 | EHT Action |
| 3 | EML Control (see 9.4.1.xx (EML Control field)) |
|  |  |

The Category field is defined in 9.4.1.11 (Action field).

The EHT Action field is defined in 9.6.x.1 (EHT Action field).

***TGbe editor: Add a new subclause 9.4.1.xx as follows:***

9.4.1.xx EML Control field

The Enhanced Multi-Link (EML) Control field is defined in Figure 9-xyz (EML Control field format).

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | B0 | | B1 | B2 B7 |
|  | EMLSR Mode | | EMLMR Mode | Reserved |
| Bits: | 1 | | 1 | 6 |
|  | | **Figure 9-xyz – EML Control field** | | |

A non-AP MLD that supports Enhanced multi-link single-radio operation (see 35.3.13 (Enhanced multi-link single-radio operation)) sets the EMLSR Mode subfield to 1 to indicate that the non-AP MLD operates in EMLSR mode and to 0 to indicate that the non-AP MLD does not operate in EMLSR mode. The EMLSR Mode subfield is set to 0 for all non-AP MLDs that don’t support Enhanced multi-link single-radio operation, for all non-AP MLDs that have set the EMLMR Mode subfield to 1, and for AP MLDs.

A non-AP MLD that supports Enhanced multi-link multi-radio operation (see 35.3.14 (Enhanced multi-link multi-radio operation)) sets the EMLMR Mode subfield to 1 to indicate that the non-AP MLD operates in EMLMR mode and to 0 to indicate that the non-AP MLD does not operate in EMLMR mode. The EMLMR Mode subfield is set to 0 for all non-AP MLDs that don’t support Enhanced multi-link multi-radio operation, for all non-AP MLDs that have set the EMLSR mode subfield to 1, and for AP MLDs.

**9.4.2.295b.2 Basic variant Multi-Link element**

***TGbe Editor: Insert the following subfields in the EML Capabilities subfield in figure 9-788eh1 (EML Capabilities subfield format):***

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Mode Transition Delay | EMLMR Support | EMLMR Delay | EMLMR Link Bitmap |
| Bits: | 3 bits | 1 bit | 3 bits | 16 bits |

**Figure 9-788eh1—EML Capabilities subfield format**

*[Note to editor: If EML Capabilities subfield is defined by other PDT/CR document, please use 23 bits from any of reserved bits in the EML Capabilities subfield that is defind by the other PDT.]*

***TGbe Editor: Insert the following text after a paragraph describing the EMLSR Delay subfield:***

The Mode Transition Delay subfield indicates the time required for an AP MLD to apply requested EMLSR/EMLMR mode from a non-AP MLD after the transmission end time of an acknowledgement frame from an AP affiliated with the AP MLD to an EML Operating Mode Notification frame from a non-AP STA affiliated with the non-AP MLD (see 35.3.14 (Enhanced multi-link single-radio operation) and 35.3.15 (Enhanced multi-link multi-radio operation)).

When the Mode Transition Delay subfield is included in a frame sent by an AP affiliated with an AP MLD, the Mode Transition Delay subfield is set to 0 for 0 TU, set to 1 for 1 TU, set to 2 for 2 TU, set to 3 for 4 TU, set to 4 for 8 TU, set to 5 for 16 TU, and the values 6 and 7 are reserved. When the Mode Transition Delay subfield is included in a frame sent by a non-AP STA affiliated with a non-AP MLD, the Mode Transition Delay subfield is set to 0.

The EMLMR Support subfield indicates support of the EMLMR operation for an MLD. The EMLMR Support subfield is set to 1 if the MLD supports the EMLMR operation; otherwise set to 0.

The EMLMR Delay subfield indicates the minimum padding duration required for a non-AP MLD for EMLMR link switch when operating in EMLMR mode (see 35.3.15 (Enhanced multi-link multi-radio operation)).

When the EMLMR Delay subfield is included in a frame sent by a STA affiliated with a non-AP MLD, the EMLMR Delay subfield is set to 0 for 0 µs, set to 1 for 32 µs, set to 2 for 64 µs, set to 3 for 128 µs, set to 4 for 256 µs, and the values 5 to 7 are reserved. When the EMLMR Delay subfield is included in a frame sent by an AP affiliated with an AP MLD, the EMLMR Delay subfield is set to 0.

When the EMLMR Link Bitmap subfield is included in a frame sent by a STA affiliated with a non-AP MLD, i-th bit in the EMLMR Link Bitmap subfield is set to 1 if a link with Link ID equal to i is a member of the EMLMR links; otherwise it is set to 0. When the EMLMR Link Bitmap subfield is included in a frame sent by an AP affiliated with a AP MLD, the EMLMR Links Bitmap subfield is set to 0.

***TGbe editor: Please update subclause 35.3.15 (Enhanced multi-link multi-radio operation) as follows:***

* + 1. Enhanced multi-link multi-radio operation

A non-AP MLD may operate in the enhanced multi-link multi-radio (EMLMR) mode on a specified set of the enabled links between the non-AP MLD and its associated AP MLD. The specified set of the enabled links in which the EMLMR mode is applied is called EMLMR links.

An MLD with dot11EHTEMLMROptionImplemented equal to true shall set the EMLMR Support subfield of the Common Info field of transmitted Basic variant ML elements to 1; otherwise, the MLD shall set the EMLMR Support subfield to 0.

A non-AP MLD with dot11EHTEMLMROptionImplemented equal to true shall set the EMLMR Rx NSS subfield of TBD element to dot11SupportedEMLMRRxNSS and the EMLMR Tx NSS subfield of TBD element to dot11SupportedEMLMRTxNSS, which indicate MLD level capabilities.

If a non-AP MLD with dot11EHTEMLMROptionImplemented equal to true intends to switch EMLMR mode after multi-link setup then a non-AP STA affiliated with the non-AP MLD shall transmit an EML Operating Mode Notification frame with EML Operation subfield equal to 1 or 0 to enable or disable EMLMR mode, respectively. When the non-AP STA transmits an EML Operating Mode Notification frame with EML Operation subfield equal to 1 or 0, the non-AP MLD enables or disables EMLMR mode, respectively, from a value indicated by the most recent Mode Transition Delay subfield it received in a frame from an AP affiliated with a peer AP MLD after successful reception of an acknowledgement frame to the EML Operating Mode Notification frame .

A non-AP MLD with dot11EHTEMLMROptionImplemented equal to true shall indicate the minimum padding duration required for the non-AP MLD for EMLMR link switch in the EMLMR Delay subfield in the Common Info field of transmitted Basic variant ML elements. .

When an AP of an AP MLD transmits a PPDU that initiates a frame exchange with a non-AP MLD operating in EMLMR mode, the AP shall ensure that the padding duration is longer than or equal to the minimum padding duration value indicated by the EMLMR Delay field from the non-AP MLD.

When a non-AP MLD operates in the EMLMR mode, after initial frame exchange subject to its per-link spatial stream capabilities and operating mode on one of the EMLMR links, the non-AP MLD shall be able to support the following until the end of the frame exchange sequence initiated by the initial frame exchange:

* Receive PPDUs with the number of spatial streams up to the value as indicated in the EMLMR Rx NSS subfield of TBD element at a time on the link for which the initial frame exchange was made.
* Transmit PPDUs with the number of space-time streams up to the value as indicated in the EMLMR Tx NSS subfield of TBD element at a time on the link for which the initial frame exchange was made.

After the end of the frame exchange sequence, each STA of the non-AP MLD in the EMLMR mode shall be able to transmit or receive PPDU, subject to its per-link spatial stream capabilities and operating mode and subject to any switching delay indicated by the non-AP MLD.